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STUDIES ON CONFORMATION IN RELATION TO MILK PRODUCING CAPACITY IN CATTLE.

III. Conformation and Milk Yield in the Light of the Personal Equation of the Dairy Cattle Judge.

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BULLETIN 314

STUDIES ON CONFORMATION IN RELATION TO MILK PRODUCING CAPACITY IN CATTLE[1]

III.[2] Conformation and Milk Yield in the Light of the Personal Equation of the Dairy Cattle Judge.

By John W. Gowen.

A step toward better dairy cattle and higher milk yields would be made if it were possible for every dairyman to judge dairy cattle and pick the better milk producers from the poorer milk producers as accurately as certain judges are able to do it. How can this goal be reached? One method, perhaps entirely obvious to all, is to study the best judges, see how they do it and then follow their methods. The data showing how the best judges select high producing dairy stock from poor producing stock are presented in the following pages together with an equally important analysis of the methods of the judges who cannot pick out the high producing cows.

Nineteen different judges are included in these data. These judges are selected to include those which had scored 25 or more cows with known milk yields. The conformation of a cow is considered under eighteen major parts in the score card of 1903, a copy of which is reproduced below.

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[1]Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 155. The Rockefeller Institute for Medical Research has furnished material aid to these animal husbandry investigations in the form of a grant for increased maintenance of the work. This paper presents one phase of these researches as conducted by the Biological Laboratory of the Maine Agricultural Experiment Station.

[2]Gowen, John W.

I. Conformation and its relation to milk producing capacity in Jersey cattle. Journal of Dairy Science, Vol. III, No. 1, January, 1920, pp. 1-32.

II. The personal equation of the cattle judge. Journal of Dairy Science, Vol. IV, No. 5, September, 1921, pp. 359-374.

Points scored by cow:

Name.....H.B. No.....

	Counts
Head, 7—	
A—Medium size, lean; face dished; broad between eyes and narrow row between horns	4.....
B—Eyes full and placid; horns small to medium, incurving; muzzle broad, with muscular lips; strong under jaw	3.....
Neck, 5—	
Thin, rather long, with clean throat; thin at withers	5.....
Body, 33—	
A—Lung capacity, as indicated by depth and breadth through body, just back of fore legs	5.....
B—Wedge shape, with deep, large paunch, legs proportionate to size and of fine quality	10.....
C—Back straight to hip-bones	2.....
D—Rump long to tail-setting and level from hip-bones to rump-bones	8.....
E—Hip-bones high and wide apart; loins broad, strong	5.....
F—Thighs flat and well cut out	3.....
Tail, 2—	
Thin, long, with good switch, not coarse at setting-on	2.....
Udder, 28—	
A—Large size and not fleshy	6.....
B—Broad, level or spherical, not deeply cut between teats	4.....
C—Fore udder full and well rounded, running well forward of front teats	10.....
D—Rear udder well rounded, and well out and up behind	8.....
Teats, 8—	
Of good and uniform length and size, regularly and squarely placed	8.....
Milk Veins, 4—	
Large, tortuous and elastic	4.....
Size, 3—	
Mature cows, 800 to 1,000 pounds	3.....
General Appearance, 10—	
A symmetrical balancing of all the parts, and a proportion of parts to each other, depending on size of animal, with the general appearance of a high-class animal, with capacity for food and productiveness at pail	10.....
	100

It is obviously impossible to reproduce all the 500 odd tables which were used in this study. Such being the case only the ordinary constants will be given. The mean score given to each part of the cow's conformation by the respective judges is shown in table 1. The judge is indicated by the same code number as that used in the former paper.[3]

The average score given any point of the cow's conformation by this group of 19 judges agrees closely with that given the whole group of 1674 cows as analyzed in the first paper on conformation in relation to milk production. The average Jersey cow on the basis of these 1674 records differs from the ideal cow by about 10 points. The greatest difference of the individual body parts from the ideal is found in the fore udder. This difference is no doubt due to the lack of size and symmetry of this part of the udder on many cows. The other parts of the average cow which differ most from the ideal form are the shape and size of the barrel and the general appearance (the symmetry and balance of the animal as a whole). The size of the average cow approached most nearly the ideal of any of the divisions used in the consideration of these animals. When the average conformation of the individual body parts are considered in relation to the perfect form, it is found that the most seriously defective places pertained to the size of the udder and its blood supply. Thus the fore udder was the farthest from the ideal type; the udder shape taken as a whole was the next; the size and character of the milk veins was considered the next farthest off the ideal form. The part of conformation which deviated least from the ideal was the size or weight of the cow. If the three main divisions into which the score card is divided are considered it is found that the body regions approach nearest to the ideal type; the head next and the udder is farthest removed from this ideal conformation. If the conformation as a whole is compared with the mammary development as a whole it is found that the body form approaches most nearly the ideal. From these considerations it becomes plain that in the minds of these judges the part of the body requiring greatest development in this ideal milch cow is the mammary system as distinguished from the rest of the body.

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[3] loc. cit.

TABLE 1.

Mean score of parts making up the conformation of the dairy cow as obtained for the 19 judges.

Judge	Head		Neck	Body						Tail	Udder				Teats	Milk veins	Size	General appearance	Total score	Milk yield
	A	B		A	B	C	D	E	F		A	B	C	D						
1	3.47	2.62	4.53	4.54	9.08	1.84	7.53	4.68	2.77	1.94	5.56	3.62	8.87	7.68	7.37	3.63	2.88	8.99	91.9±.2	7645±106
2	3.57	2.76	4.30	4.85	9.45	1.79	7.30	4.76	2.75	1.79	5.40	3.53	8.56	7.39	7.06	3.54	2.87	9.31	91.5±.3	8095±87
6	3.42	2.39	4.50	4.86	9.10	1.74	6.63	4.85	3.00	1.90	5.10	3.30	8.38	7.51	7.35	3.79	3.00	9.91	90.6±.3	6905±143
20	3.54	2.77	4.49	4.78	8.92	1.72	7.57	4.82	2.81	1.90	5.46	3.61	9.09	7.34	7.16	3.32	2.88	9.68	91.8±.4	8320±219
31	3.57	2.72	4.57	4.63	9.03	1.78	7.26	4.73	2.79	1.94	5.15	3.57	8.79	7.40	7.51	3.30	2.88	9.45	91.1±.1	7847±108
33	3.61	2.71	4.55	4.59	9.36	1.81	7.40	4.57	2.84	1.89	5.48	3.58	9.05	7.54	7.44	3.35	2.89	9.41	92.0±.2	8063±108
37	3.54	2.58	4.49	4.68	9.34	1.73	6.86	4.54	2.66	1.89	5.40	3.43	8.18	7.31	7.01	3.53	2.89	8.62	89.2±.4	8245±192
47	3.63	2.75	4.43	4.66	8.75	1.75	7.16	4.53	2.76	1.90	5.30	3.48	8.72	7.33	7.29	3.61	2.88	9.25	90.4±.3	7455±167
51	3.57	2.80	4.66	4.64	9.19	1.85	7.40	4.60	2.86	1.90	5.73	3.66	8.88	7.53	7.42	3.53	3.00	8.33	91.0±.3	7580±194
52	3.63	2.77	4.49	4.47	8.92	1.84	7.55	4.59	2.62	1.92	5.07	3.25	8.84	7.08	7.09	3.35	3.00	8.99	89.2±.4	7115±201
58	3.39	2.45	4.15	4.34	8.70	1.86	7.12	4.28	2.80	1.68	4.79	3.03	7.98	6.99	6.99	3.48	2.89	8.62	85.5±.5	7538±215
59	3.57	2.64	4.45	4.79	9.09	1.81	6.79	4.61	2.58	1.84	5.72	3.54	8.30	7.42	7.14	3.59	2.86	8.31	89.4±.3	8147±159
76	3.30	2.53	4.34	4.62	9.37	1.61	7.22	4.66	2.82	1.86	5.65	3.71	8.59	7.28	7.38	3.72	2.87	9.13	90.4±.5	8156±210
80	3.64	2.70	4.63	4.80	9.45	1.72	7.49	4.74	2.89	1.92	5.80	3.37	8.46	7.63	6.98	3.63	3.00	8.99	91.7±.4	7380±227
84	3.33	2.32	4.07	4.17	8.77	1.67	6.77	4.12	2.54	1.82	4.95	3.02	8.11	7.20	6.74	3.42	2.80	9.32	85.7±.6	7833±153
89	3.67	2.67	4.40	4.72	9.30	1.88	7.39	4.72	2.73	1.95	5.61	3.67	8.80	7.06	7.09	3.74	3.00	9.52	91.8±.4	8385±205
102	3.52	2.58	4.79	4.80	9.27	1.61	7.03	4.29	2.81	1.83	5.26	3.33	8.58	7.25	7.04	3.55	2.85	9.68	90.4±.3	7144±160
117	3.56	2.57	4.26	4.38	8.68	1.80	7.28	4.44	2.42	1.88	5.06	3.56	8.31	7.20	7.28	3.28	2.65	8.71	87.2±.4	7286±132
118	3.62	2.69	4.49	4.74	9.19	1.86	7.41	4.80	2.75	1.85	5.19	3.48	8.70	7.51	7.36	3.76	2.88	9.22	91.5±.3	7000±107

The average scores given to the different body parts by the different judges vary considerably. Thus the general appearance of the cows of the different groups has the greatest variation. The size and character of the udder and the shape of the fore udder are the next most variable in their average score. The size and shape of the rump and body are quite variable in their average score. It will be noted that these parts all relate in one way to the items favoring milk production in the cow. The least variable parts are in general those least affecting milk yield. These points are the tail, the size, the contour of the back and the character of the face.

It is of interest to examine the conformation of the different parts as given by the judges to see if there is any correspondence between the mean score of the part and the mean milk yield of the group. That is, if the mean milk yield of one group is 9000 pounds and the mean milk yield of another group is 7000 pounds, will the judge of the first group place the conformation of this group nearer the ideal form than the judge of the 7000 pound group. Examination of table 1 shows that the higher the average milk yield of any judge's group of cattle the larger and better shaped the udder as seen by the different judges. The size of the barrel and the wedged shaped form also appear to be more nearly ideal as the average milk yield of the group increases. Curiously enough the judges do not emphasize the character of the milk veins in distinguishing between the milk yields of the different groups although within any one group the milk veins are the leading character used by the judge to pick out the high producing cow from the low producer.

Variation of the Score for Each Individual Point of Conformation.

The variation of the scores of the individual cows on each part of conformation and for each judge are given in table 2. Each judge is represented by the same code number which he had in table 1.

The average standard deviations of the different parts making up the whole conformation of the animal are slightly less than those where all records are grouped together as was done in the

TABLE 2.

Standard deviations of the parts making up the conformation of the dairy cow as obtained for the 19 judges.

Judge	Head		Neck	Body						Tail	Udder				Teats	Milk veins	Size	General appearance	Total score	Milk yield
	A	B		A	B	C	D	E	F		A	B	C	D						
1	.30	.22	.28	.33	.66	.17	.46	.32	.17	.15	.35	.30	.64	.33	.48	.21	.11	.53	3.66	1745
2	.45	.25	.56	.21	.70	.19	.75	.35	.28	.27	.63	.47	1.06	.73	.77	.49	.14	.66	4.91	1576
6	.25	.29	.27	.17	.58	.26	.66	.13	—	.24	.60	.44	.66	.47	.51	.25	—	.19	3.30	1381
20	.37	.17	.41	.23	.85	.21	.40	.16	.20	.15	.47	.27	.92	.69	.78	.44	.10	.48	3.50	2024
31	.23	.18	.35	.27	.64	.22	.56	.21	.15	.08	.53	.29	1.00	.55	.51	.27	.10	.56	2.48	1944
33	.25	.18	.28	.31	.49	.14	.32	.21	.15	.14	.37	.25	.73	.37	.49	.35	.07	.53	3.19	1908
37	.32	.21	.36	.38	.60	.26	.63	.31	.20	.13	.54	.36	1.16	.44	.67	.32	.04	.69	3.76	2028
47	.30	.16	.37	.31	.80	.19	.70	.40	.15	.12	.38	.37	.86	.53	.57	.32	.06	.43	3.98	2011
51	.39	.10	.11	.13	.53	.10	.54	.21	.10	.18	.29	.19	.56	.37	.47	.17	—	.49	2.19	1440
52	.30	.17	.38	.37	.66	.11	.32	.38	.30	.18	.45	.40	.80	.54	.46	.40	—	.66	3.25	1521
58	.39	.41	.59	.44	.48	.10	.51	.41	.17	.29	.54	.27	.52	.49	.46	.37	.04	.72	3.87	1629
59	.36	.37	.49	.31	.87	.23	.89	.50	.43	.29	.43	.48	1.28	.61	.72	.43	.19	1.23	2.75	1678
76	.52	.41	.50	.39	.75	.31	.55	.40	.22	.24	.37	.30	.83	.61	.49	.33	.17	.58	4.14	1761
80	.30	.20	.26	.17	.51	.14	.39	.18	.04	.13	.23	.27	.70	.32	.37	.23	—	.49	2.82	1681
84	.48	.45	.53	.51	.74	.34	.52	.46	.51	.34	.60	.44	.81	.63	.79	.47	.30	.73	5.67	1420
89	.27	.15	.40	.20	.51	.05	.41	.19	.16	.11	.23	.22	.80	.47	.52	.23	—	.46	2.73	1552
102	.35	.37	.17	.24	.47	.32	.43	.40	.17	.29	.45	.36	.72	.45	.46	.38	.20	.44	3.24	1820
117	.27	.25	.36	.48	.55	.18	.49	.41	.39	.17	.45	.31	.83	.64	.55	.39	.36	.62	4.02	1264
118	.26	.24	.37	.21	.46	.09	.50	.22	.20	.17	.44	.46	.70	.48	.52	.23	.07	.38	2.95	1195

first paper dealing with this subject. This is to be expected from the mode of derivation of the standard deviation for such a combined group. Considered in relation to the average score the shape of the udder is the most variable part of the conformation. The least variable is the size. The general appearance of the cow and the shape of the fore udder have the most variation when scored by the different judges.

There is some correlation between the variation of the different parts and the variation of the milk yield. The variation of the shape of the body and size of the barrel is correlated with the variation of the milk yield such that the more the different cows vary in the barrel, the more the milk yield varies. A similar correlation exists for the shape and size of the fore udder.

Correlation Between the Points of Conformation and Milk Yield.

With these basic data in hand we may proceed to the relations which exist between the score given a part of the conformation by the judge and the milk yield of the cow. Here we have a means of analyzing the personal equation of each judge in comparison with his real ability in selecting the high or low producing cow on the basis of her conformation. Again the points of the dairy cow's conformation which are emphasized by these judges, may be compared with the milk yields of the cows to determine the worth of these points as a basis for selecting dairy cattle. Table 3 gives the correlation coefficients between the score of each individual point of conformation and the milk yield of the cow.

Each judge is an able cattleman whose name would be recognized by most of my readers. Each has his personal equation in judging cattle. By averaging the correlation coefficients an average of the personal equations of the different judges is obtained. These average correlation coefficients for each part of the body making up the conformation are given in the lower line of table 3. The order of merit of the five leading points for indicating milk yield is (1) total score, (2) milk veins, (3) rear udder, (4) udder large size, (5) body wedge shape. These are the principal points which are indicative of milk yield. Their

TABLE 3.

Correlation coefficients between milk yield and the conformation of the individual parts for the different judges.

Judge	Head		Neck	Body					
	A	B		A	B	C	D	E	F
1	.233±.057	.103±.060	−.062±.060	.058±.060	.170±.059	−.104±.060	.052±.060	.186±.058	.103±.060
2	.070±.055	.136±.054	.097±.055	.146±.054	.046±.055	.059±.055	.117±.055	.113±.055	.150±.054
6	−.323±.093	.008±.104	−.197±.103	−.127±.102	.324±.093	.077±.103	.022±.104	.016±.104	----------
29	.094±.107	.108±.107	.330±.096	.107±.107	.583±.071	−.114±.107	.010±.108	−.099±.108	.072±.107
31	−.207±.053	−.032±.056	−.178±.054	−.090±.055	.189±.054	−.178±.054	.100±.055	−.073±.055	−.093±.055
33	.192±.055	.168±.055	.147±.055	.067±.056	.350±.050	.688±.030	.218±.054	.086±.056	.131±.056
37	.026±.094	.168±.092	−.063±.094	−.148±.092	.253±.088	.065±.094	.292±.086	.292±.086	.067±.094
47	.081±.082	−.291±.076	−.045±.083	−.248±.078	−.062±.083	−.181±.080	.145±.081	.076±.083	−.161±.081
51	.176±.131	−.058±.131	.314±.122	.149±.132	.063±.134	−.137±.132	−.097±.134	−.077±.134	−.091±.134
52	−.279±.122	−.382±.113	−.043±.132	−.277±.122	.112±.131	.090±.131	−.058±.132	.089±.131	.189±.128
58	−.414±.110	−.392±.112	.320±.119	.104±.131	.046±.132	−.089±.131	.134±.130	−.147±.129	.378±.113
59	−.241±.089	−.170±.092	.195±.091	.130±.093	.029±.094	−.301±.086	.152±.092	.149±.092	.386±.080
76	.075±.119	.205±.114	.235±.113	−.087±.118	.485±.091	−.198±.115	.058±.119	−.120±.118	.287±.109
80	.227±.128	.047±.135	.232±.128	−.238±.127	−.014±.135	.213±.129	−.029±.135	.176±.131	−.130±.132
84	.076±.107	.097±.107	.637±.064	.516±.079	.485±.083	−.179±.105	.435±.088	−.000±	.286±.099
89	.414±.110	.307±.120	.455±.105	.008±.132	.372±.114	.072±.132	.179±.128	.467±.103	.075±.132
102	.339±.078	.119±.087	.167±.085	−.144±.086	.337±.078	−.252±.082	.088±.087	.156±.086	.300±.080
117	.016±.105	−.005±.105	.159±.103	−.065±.105	−.264±.098	−.124±.104	.257±.098	.085±.105	.150±.103
118	.040±.090	−.188±.087	.096±.089	.184±.087	.058±.090	−.017±.090	.220±.086	.061±.090	−.187±.087
Average	+.031	−.003	+.142	+.002	+.188	−.032	+.110	+.080	+.106

TABLE 3—Continued.

Tail	Udder				Teats	Milk veins	Size	General appearance	Total score
	A	B	C	D					
—.096±.061	.328±.054	.133±.059	.113±.060	.263±.056	.172±.059	.358±.053	.057±.060	.268±.056	.174±.058
.050±.055	.281±.051	.124±.055	.021±.055	.254±.052	.148±.054	.147±.054	.164±.054	.182±.054	.241±.052
—.162±.101	.211±.099	.420±.086	—.141±.102	.288±.095	.057±.104	.066±.104	----------	.146±.102	.222±.099
.259±.101	.215±.103	.325±.097	.138±.106	.485±.083	.299±.098	.473±.084	.135±.106	.410±.090	.578±.072
.081±.055	.221±.053	.004±.056	—.039±.056	.218±.053	—.003±.056	.310±.050	.049±.055	—.024±.056	.097±.055
.013±.057	.417±.047	.238±.053	.190±.055	.332±.050	.211±.054	.410±.047	.024±.057	.331±.050	.428±.046
.134±.093	—.163±.092	—.065±.094	.129±.093	.081±.094	.024±.094	.385±.080	.024±.094	.297±.086	.413±.078
—.042±.083	.048±.083	—.091±.082	—.183±.089	—.120±.082	—.097±.083	.228±.079	—.172±.081	—.202±.080	—.098±.082
.220±.128	.450±.108	.012±.135	—.078±.135	.266±.125	.249±.127	.489±.103	----------	.082±.134	.228±.128
—.048±.132	.402±.111	.147±.129	.187±.128	.240±.125	.239±.125	—.034±.132	----------	.127±.130	.205±.127
.125±.130	.022±.132	—.133±.130	—.238±.127	.353±.116	—.394±.112	.484±.101	—.118±.130	—.222±.126	—.077±.131
.067±.094	.131±.093	—.181±.091	.046±.094	.082±.094	.247±.089	.138±.093	.078±.094	—.058±.094	.160±.092
.202±.114	.283±.110	.231±.113	.134±.117	.318±.107	.596±.089	.216±.114	—.239±.112	.163±.116	.417±.098
—.067±.134	.111±.133	—.192±.130	—.169±.131	.130±.133	.259±.126	.244±.127	----------	.122±.133	.170±.131
.301±.098	.585±.071	.264±.100	.459±.085	.534±.077	.428±.088	.548±.076	.139±.106	.386±.092	.614±.067
.174±.128	.035±.132	.125±.130	—.047±.132	.241±.125	—.054±.132	—.247±.124	----------	.158±.129	.405±.111
.141±.086	.125±.086	.304±.080	.373±.076	.194±.085	—.030±.088	.192±.085	.219±.084	.402±.074	.363±.076
.068±.062	.134±.061	—.296±.058	—.020±.062	—.019±.062	—.061±.062	—.052±.062	.065±.062	.033±.062	.027±.104
—.099±.089	.096±.089	.068±.090	.027±.090	.134±.089	—.036±.090	.064±.090	—.066±.090	.006±.090	.106±.089
+.074	+.207	+.076	+.053	+.225	+.119	+.233	+.025	+.137	.246

order of merit is practically the same as that given in a former paper on this same subject.[4]

The total score has the highest average correlation with milk yield. A study of the correlation coefficients between total score and milk yield as given in the last right hand column of table 3 shows that the different men vary considerably in their ability to judge the cows for their milk yield. Out of the nineteen men who judged different groups of Jersey Registry of Merit cattle, nine clearly could judge dairy cattle by the score card and select the better milkers, eight were mediocre judges, and two were worse than mediocre, giving the low producing cows better scores than the high producers. On the correlation scale, the range of ability was large, from 0.614 to —0.098. The average ability of this group of judges to score cattle for milk yield was 0.246. This is about 25 per cent better than is the judgment of the average trained dairyman as given for all cattle.

As shown in a former paper[5] there is no relation between the average score given by each judge to his group of cows and the ability of that judge to score those cows for milk production. When it is noted that the mental scale of each judge differs considerably this fact is significant. It shows clearly why two equally good judges of cattle may place their cows several points apart, while at the same time they keep the cows in the relative order of milk yield.

The comparison of the mean milk yields of the different groups of cows with the ability of the judges to score cattle shows that the cows whose average milk yields are the larger are more easily judged for milk yield than are the groups of cows whose average milk yields are lower. Likewise, the groups composed of cows with quite variable milk yields are more easily judged than are those groups of cows which have closely similar milk yields. It is furthermore shown that the men who can score cattle most accurately for milk yield tend to have their scores show more variation than do the men who cannot score cattle as well.

The raw data for our problem, "to analyze wherein lay the superiority or inferiority of a cattle judge in determining by a

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[4]Gowen, John W.
1920. Conformation and its relation to milk producing capacity in Jersey cattle. In Jour. Dairy Science, Vol. III, No. 1, pp. 1-32.
[5]loc. cit.

cow's conformation what her probable milk yield would be" are now presented. In treating these data the question arises as to how to select the good judges, the fair judges, or the poor judges of dairy cattle. It seems fairly obvious that if a judge can select the good from the poor cows on the basis of their total score he is a good cattle judge. On the other hand, it might be true that a judge whose opinion on all of the points of conformation was not particularly good, would still be an expert judge of dairy cows when it came to some individual point like milk veins. It is, therefore, desirable to study those judges who are able to select the good cows by some one individual point of conformation. Then, too, it appears equally obvious that the choice of the parts of conformation, on which to classify the good, fair or poor judges, should be based on those points which are in themselves valuable to the average dairyman in determining a cow's probable milk yield. With these considerations in mind the author has chosen to analyze the data contained in table 3 as follows. The good, fair, or poor judges are determined on the basis of their ability to select cows for milk yield by the following points of conformation presented in order of their relative merit for determining probable milk yield (1) total score, (2) milk veins, (3) udder, large size, (4) rear udder well rounded, (5) body wedge shaped, (6) general appearance, (7) thighs, (8) fore udder.

Total Score and Good, Fair, and Poor Judges.

In the data available for the correlations between the different parts making up conformation and milk yield as given in table 3, a means is offered for determining on what points the judges, who can select cattle by their total score and pick the high producers from the low producers, place their emphasis. If the correlation coefficients for the relation between a given point of conformation and milk yield are correlated with the correlation coefficients for the relation of total score and milk yield, a measure will be obtained of the emphasis placed on the different points by the good, or poor judges. These correlation coefficients have been obtained and are given in table 4, arranged in order of their magnitude.

TABLE 4.

Correlation coefficients for the correlations of total score and milk yield with the correlations of the other parts of conformation and milk yield.

Character	Correlation coefficients
General appearance	.88
Body—wedge shape	.85
Fore udder	.73
Eyes full and placid	.71
Udder—broad, level, or spherical	.66
Rear udder	.66
Teats	.61
Tail	.58
Neck	.49
Head—medium size	.43
Lung capacity	.36
Udder—large size and not fleshy	.36
Thighs flat and well cut out	.30
Size	.28
Rump long	.25
Milk veins	.23
Hip-bones	.18
Back straight to hip-bones	.18

The correlation coefficients of the correlations between the score of the character and milk yield and the total score of the given judge and the milk yield of his cows are given in table 4. In studying table 4 the correlation coefficients of each part should be considered together with the average correlation coefficient of that part as given in table 3. These constants show the points of conformation by which the good judge is able to place his cows more nearly in their relative order of milk yield than the poor judge. The highest correlation coefficient is for the general appearance of the cow. That is, the good judges are able to place the cows much better, as regards milk yield, by their general appearance than are the poor judges of dairy cattle. The good judges also see a high relation between body shape and milk yield that is not seen by the poor judges. In the same manner the fore udder, appearance of eyes and size of the muzzle, the udder as a whole, the rear udder and condition and placement of the teats are points wherein the good judges are able to select the

better milkers from the poorer milkers to a greater extent than are the poor judges.

Let us return and examine what the true value of these points in themselves may be in showing the probable milk yield of the cow. The average correlation coefficients of table 3 give these data. It is found that general appearance has some relation to milk yield but that it is not so large as the relation of, say, milk veins to milk yield. Similarly body shape has some relation to milk yield, higher in fact than general appearance, and yet the good judge places his cows less accurately in their relative order of milk yield by it than he does by the general appearance of these cows. This is particularly true of the fore udder, the good judges finding much in it to indicate the good cow, but the fore udder is itself averaged to be only slightly indicative of the good cow. These facts show that something else is needed to complete this study. While table 4 is strikingly suggestive we need to go further and analyze each group separately. The correlation coefficients between total score and milk yield range from .614 to —.098 as seen in the last column of table 3. Three groups will be made. The first group will include the 6 judges whose total score has the highest correlation with milk yield. The average correlation for the group is .476. The second group will include the next 6 judges arranged according to the correlation between total score and milk yield. The average correlation for the group is .239. The last group contains the 7 judges who had the lowest relation between total score and milk yield. Their average was .055. The first group might be considered the best judges and called 1; the second group the fair judges and called 2; the third group the poor judges and called 3. The average correlation coefficients for each group of judges and for each part of conformation is given in table 5.

While some of the same points are shown in table 5 as were shown for table 4, the facts shown in table 4 are more easily and correctly interpreted by a comparison with table 5. The average correlation coefficients for the milk yield and score on the A of Head for group 1 judges is .15; that for group 2 is .04; and for group 3 is —.07. It will be noted that while these correlation coefficients are small they decrease steadily as the correlation coefficients between the total score and milk yield decrease. That is, there is some relationship between a judge's ability to place his

TABLE 5.

Average correlation coefficients for parts of body conformation and milk yield for the best judges, group 1, the fair judges, group 2, and the poor judges, group 3. The arrangement of the judges is based on their correlation coefficients between total score and milk yield given in table 3.

Judge's group	Parts of Conformation									
	Head		Neck	Body						Tail
	A*	B		A	B	C	D	E	F	
1	.15	.18	.29	.08	.42	.06	.20	.12	.15	.18
2	.04	—.01	.06	—.03	.18	—.05	.02	.08	.11	.03
3	—.07	—.15	.08	—.03	—.00	—.10	.11	.05	.05	.02

Udder				Teats	Milk veins	Size	General appearance	Total score
A	B	C	D					
.23	.19	.17	.33	.24	.30	.01	.29	.48
.30	.19	.09	.25	.14	.20	.07	.20	.24
.11	—.12	—.08	.11	.00	.20	—.02	—.05	.06

*The significance of the divisions may be seen from the score card presented earlier.

cows on the basis of the conformation of their A of head for milk yield and the ability of the judge to place his cows on the basis of their total score for milk yield even though the character of the A of head is not a good indicator of milk yield. It will be noted that this is very distinctly true of the B of head, the average correlation coefficient declining steadily. This relatively large average size of the correlation coefficients for the first group (1) steadily declining through the second group (2) to the third group (3) is accentuated for general appearance, B of body and C of udder even though the value of these parts may be small in pointing to the high or low milk yielding cow. This point is very nicely illustrated in the case of the body wedge shaped, as compared with the characters of the fore udder. While the body

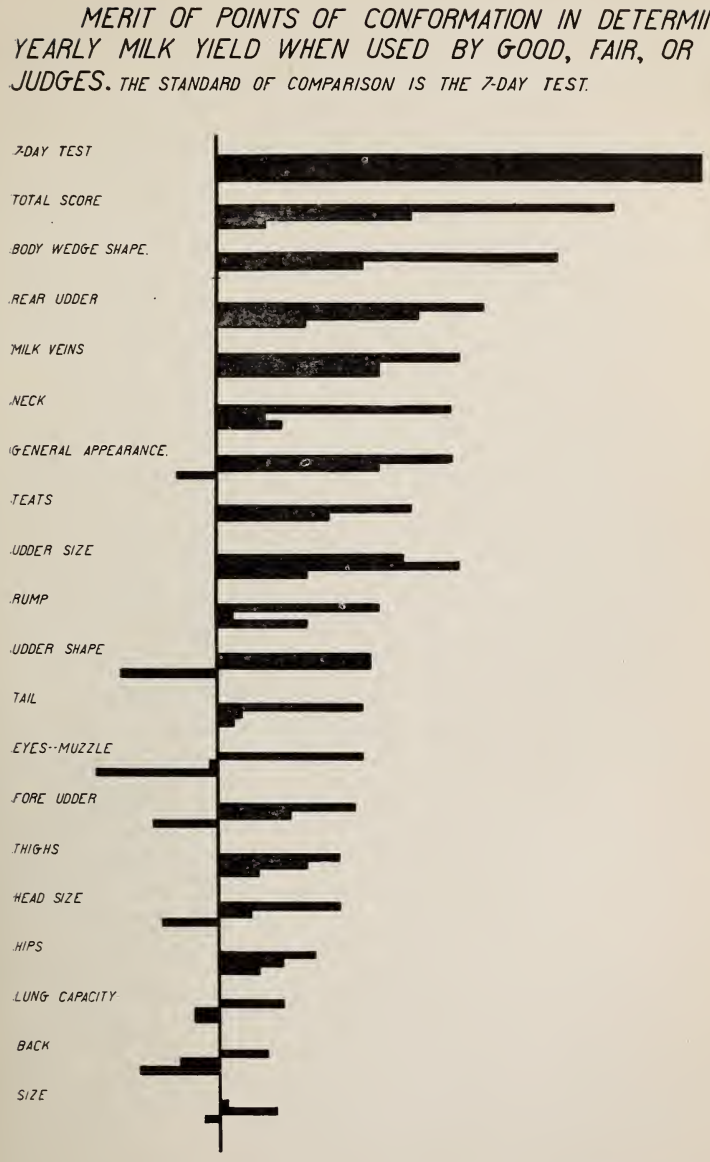

FIG. 23. The length of the bars represent the average value of the correlation coefficients as given in table 5.

shape is probably more than 4 times as good an indicator of milk yield as the character of the fore udder, the good judges find in both, indications of the good cows whereas the group 3 judges find little or no value in either one.

Figure 23 shows these facts graphically. The length of the black bars represents the numerical value of the correlation coefficients. The first bar gives the relation between the 7-day and 365-day tests as determined for Holstein-Friesian cattle. The succeeding bars give the relative value of the leading diagnostic points of conformation for milk yield as derived in table 5. The upper bar gives the value for the first group of judges, the second bar the fair judges and the third bar the poor judges. Where no bar is indicated the average correlation coefficient is zero.

If a comparison is made between the short time milk yield and any point of conformation as to the merits of the two for predicting milk yield it is clear that no point of conformation, even in the hands of judges selected for their ability to judge cattle, is equal to a milk record of so short a time as 7 days.

Another kind of relation may be noticed. It will be remembered that the character of the milk veins is one of the best points of conformation in showing the probable milk yield of the cow. It will be noted in table 5 that while the group 1 judges were a little better able to judge the cow's milk yield from her milk veins than were groups 2 and 3, the average correlation coefficients for 2 and 3 were the same. Furthermore for all these groups the average correlations are high as compared with the other points of conformation. Under such circumstances it is apparent that here, in milk veins, is a point that can be used by even the unskilled with a fair degree of success, in picking out the better milking cows. Another similar point might be mentioned in the size and character of the udder.

A significant fact presents itself if the whole table be scanned. It will be noticed that in almost every case that the group (1) judges have larger average correlation coefficients for each of the different points of conformation and milk yield than either group 2 or 3 judges for these items. Similarly the group 2 judges have a larger relation for the points of conformation and milk yield than the group 3 judges. This larger size of the average group 1 correlation coefficients as compared with those of group 2 could be explained by two hypotheses. The fact that the groups of

judges were chosen on the basis of the correlation coefficient for score and milk yield would tend to make the average correlation coefficients for group (1) larger than those of group (2) and those of group (2) larger than group (3) because the net correlation for total score and milk yield is partly determined by the placement of a cow on the basis of her individual parts of conformation. The other hypothesis to account for this difference would be that the judges of group (1) were actually more able cattle judges for milk yield based on any or all parts of conformation than were the judges of group (2), and similarly the judges of group (2) were better judges than those of group (3). As shown later the second hypothesis appears correct.

Milk Veins and Good, Fair, and Poor Judges.

There are other ways of arranging these judges into the three groups of ablest, fair, and poor. Thus the points of conformation, milk veins, the udder—large size, the rear udder, the body wedge shaped, the general appearance, thighs, the rump, the fore udder, are all worth the consideration of the dairyman in selecting a dairy cow. These 19 judges, who are now being studied, varied in their ability to use these points in choosing the good dairy cow. To obtain the greatest possible knowledge of the relative value of the different points in selecting dairy cattle it becomes necessary to study all of these points. This will be done in the sections which are to follow.

The character of the milk veins was found to be one of the most reliable characteristics in selecting the high yielding cows from the low yielding cows. This point is an individual point of conformation and the judgment of it should be little influenced by other parts of conformation. It will further be remembered that the character of the milk veins was used by the previous three groups of judges about equally well in determining the probable milk yield of the cows. The correlation coefficients between the correlation of score for milk veins and milk yield and the other parts of conformation and milk yield are given in table 6.

TABLE 6.

Correlation coefficients for the correlation of milk veins and milk yield with the correlations of the other parts of conformation and milk yield.

Character	Correlation coefficient
Body—hip bone	—.53
Tail	.50
Rear udder	.44
Lung capacity	.40
Head—eyes full	—.33
Udder—large size	.32
Neck	.26
Teats	.26
Body—wedge shape	.24
Fore udder	.22
Total score	.18
General appearance	.12
Rump long	.11
Head—medium size	—.12
Thighs	.07
Udder—broad, level	.07
Body—back straight	.04
Size	.01

Examination of table 6 shows that the judges who select cows of good milk yield by means of the milk veins place a negative emphasis on the body—hip-bones high and wide apart. Expressed differently this means that the good judges on the basis of milk veins are the poor judges on the basis of body—hip-bones high, etc. and the poor judges on the basis of milk veins were the good judges on the basis of the body—hip-bones high etc. The tail,—long, etc is emphasized by the good judges but not by the poor ones. These two points, character of the hip-bones and of the tail, are rather inferior parts by which to judge the cow. The appearance of the rear udder is a valuable one. This point is given emphasis by the fact that the good judges on the basis of milk veins are also good judges on the basis of the rear udder whereas the poor judges on one are poor on the other.

These facts show the need of a table for the good, fair, and poor judges, based on milk veins, similar to table 5. This is presented in table 7. The average correlation coefficients for the 19 judges divided into three groups according to their ability to

select the high milking cows from the low milking cows on the basis of their milk veins are given in table 7. To avoid confusion the ablest group is called (4), and has an average correlation for milk veins and milk yield of .465 for its 6 judges; the next group is called (5) with an average correlation of .258 for its 6 judges; the lowest group is called (6) and has an average correlation of .012 for its 7 judges.

TABLE 7.

Average correlation coefficients for parts of body conformation and milk yield for the best judges, group 4; the fair judges, group 5; and the poor judges, group 6. The arrangement of the judges is based on their correlation coefficients between the score of the milk veins and the milk yield.

Judge's group	Head		Neck	Body						Tail
	A	B		A	B	C	D	E	F	
4	.03	.02	.28	.13	.30	.04	.17	.02	.14	.18
5	.13	.03	.06	—.13	.18	—.12	.04	.07	.05	.05
6	—.04	—.04	.10	—.00	.10	—.02	.13	.14	.11	.01

Udder				Teats	Milk veins	Size	General appearance	Total score
A	B	C	D					
.25	.11	.11	.34	.14	.47	.03	.21	.37
.19	.07	.04	.17	.15	.26	—.02	.12	.19
.18	.06	.01	.17	.08	.01	.04	.09	.20

The character of the neck, of the size and shape of the body, the rear udder and general appearance of the cow are the points, which have value in indicating the good cow, emphasized by the good judges. Of the other points which indicate the good producing cow from the poor one, the udder large sized not fleshy is a point where the good and the poor judges are about equally able to choose the better milking from the poorer milking cows.

OTHER PARTS OF CONFORMATION AND GOOD, FAIR, AND POOR JUDGES.

The two previous cases give a fairly complete picture of the methods used in approaching this problem and the conclusions to be drawn from them. There are, however, a number of other important points of conformation on which we may separate the good, fair, and poor judges and determine the points on which these three groups of judges lay emphasis. The tables showing these comparisons will be given together as they lead to essentially the same general conclusions.

TABLE 8.

Correlation coefficients for the correlation of a given conformational point and milk yield with the correlation of other parts of conformation and milk yield.

Parts of conformation	Point of conformation for which the comparison is made							Average of all points
	Udder A	Udder D	Body B	G. App.	Body F	Body D	Udder C	
Head A	—.02	—.06	.14	.51	—.25	.08	.35	.08
B	.01	.29	.56	.68	.05	.08	.37	.21
Neck	.25	.53	.31	.23	.31	.32	.24	.31
Body A	.38	.60	.26	.16	.31	.63	.37	.39
B	.27	.70	—	.67	.30	.08	.58	.41
C	.14	.18	.09	.23	—.23	.09	—.12	.01
D	—.09	.05	.08	.11	.22	—	.35	.12
E	—.33	—.30	—.01	.25	—.10	.19	.11	—.09
F	.18	.31	.30	.20	— —	.22	.68	.28
Tail	.21	.57	.53	.35	.38	.31	.52	.42
Udder A	—	.61	.27	.35	.18	—.09	.41	.29
B	.72	.59	.83	.67	.20	—.09	.50	.44
C	.41	.40	.58	.76	.68	.35	—	.49
D	.61	—	.70	.47	.31	.05	.40	.43
Teats	.61	.41	.42	.48	.09	—.02	.54	.35
Milk Veins	.32	.44	.24	.12	.07	.11	.22	.22
Size	.30	.17	.28	.67	.18	.13	.31	.26
G. App.	.35	.47	.67	—	.20	.11	.76	.38
Total score	.34	.61	.83	.82	.22	.31	.73	.50

It is noticeable on inspection that the judge who can place his cows on the basis of the texture and size of their udders (column 2) is able to place his cows better than the other judges on the basis of the other udder parts. The placement of the teats also offers this judge a good point by which to select the high or the low producing cows. The table showing the value of the different points in indicating the worth of the cow in milk production as determined by the judges who were good, fair, or poor in

judging cattle for milk yield by the point, Udder A, may now be given, as the interpretation of table 8 also depends on this table. The table also contains the same information for the other points of conformation which was used in determining the ability of the cattle judge.

The average correlation coefficients of each of the three groups of judges for the different characters and milk yield are given in table 9. The seventh group judges constitute those who could select the high milk producing cows from the low milk producing cows on the basis of their udder, large size and not fleshy. The group 8 judges were inferior to the group 7 but better than group 9. The group 9 judges were those which were least able to select the high milking cows from the low milking cows on the basis on the size and texture of the udder. In a similar manner the data are tabulated for the other groups of judges. The point of conformation on which the ability of the judges is graded is indicated at the beginning of each group. The conclusions for each division of conformation as drawn from a study of tables 8 and 9 may be briefly indicated as follows, the *italics* indicate the point of conformation on which the ability of the judges was determined.

Udder A. The neck; the wedge shape and size of the body; the thighs; the udder broad, level; the fore udder; the rear udder; the teats; the milk veins; the general appearance and the total score are all points of conformation found valuable in judging dairy cattle by the judges who can select cows for milk yield on the basis of the udder large sized, udder A.

Udder D. The good cattle judge in contrast to the poor judge (as determined by his ability to choose the high milking cow from the low milking one by appearance of the rear udder), is able to place his cows more nearly in their relative order of milk yield by the appearance of the following points given in order of merit; the body wedge-shaped; the total score of the animal; the large size of the whole udder; the lung capacity, the broad level udder; the character of the tail; and the neck (table 8). The points wherein the good judges find most to indicate the productive capacities of the cow are neck; body—wedge-shaped; thighs; udder—large sized; udder—broad not cut between teats; fore udder; teats; milk veins; general appearance; and total score (table 9).

TABLE 9.

Average correlation coefficients for score in conformation and the milk yield of the cow for these groups of judges. The judges are determined as good, fair or poor on the basis of their ability to select the higher milking cows from the lower milking cows on the basis of the score on the part of conformation indicated.

Parts of Conformation	Point of conformation by which the ability of the judge was determined																					Average*		
	Udder A			Udder D			Body B			G. App.			Body F			Body D			Udder C					
Group No.	good 7	fair 8	poor 9	good 10	fair 11	poor 12	good 13	fair 14	poor 15	good 16	fair 17	poor 18	good 19	fair 20	poor 21	good 22	fair 23	poor 24	good 25	fair 26	poor 27	good	fair	poor
Head A	.08	—.10	.10	—.05	.07	.07	.20	—.06	—.03	.16	.03	—.08	—.07	.17	.06	.13	—.02	—.01	.08	.05	—.03	.07	.03	.01
B	.02	.01	—.03	.03	.01	—.05	.17	—.03	—.12	.13	.05	—.16	—.09	.14	—.06	.09	—.07	—.03	.05	—.00	—.05	.05	.02	—.07
Neck	.21	.08	.14	.26	.10	.08	.33	—.02	.12	.19	.15	.10	.25	.19	.03	.21	.16	.07	.25	.06	.12	.25	.10	.10
Body A	.07	.02	—.07	.10	—.00	—.08	.08	—.07	.00	.08	—.10	.02	.04	.05	—.07	.09	—.02	—.06	.03	.09	—.09	.08	—.02	—.04
B	.28	.15	.14	.38	.16	.05	.44	.19	—.02	.36	.22	.01	.25	.21	.08	.21	.15	.20	.39	.10	.08	.31	.17	.09
C	.03	—.10	—.03	.03	—.03	—.09	.00	.03	—.06	.02	.05	—.15	—.15	.08	—.04	.09	—.16	—.02	.01	—.07	—.03	.01	—.04	—.06
D	.10	.08	.15	.15	.01	.16	.16	.02	.14	.18	.05	.10	.14	.14	.07	.27	.12	—.03	.13	.12	.09	.15	.07	.12
E	.03	.05	.15	—.03	.12	.14	.10	.07	.07	.12	.12	.01	.02	.16	.08	.17	.04	.04	.03	.12	.09	.06	.09	.09
F	.15	.11	.05	.19	.06	.06	.19	.03	.08	.16	.09	.06	.30	.11	—.10	.09	.22	.01	.21	.07	.03	.19	.09	.06
Tail	.11	.06	.05	.12	.08	.03	.18	.04	.02	.14	.03	.06	.13	.09	.04	.10	.09	.04	.15	.06	.03	.14	.06	.04
Udder A	.41	.20	.04	.29	.29	.07	.28	.24	.12	.25	.22	.16	.26	.24	.13	.18	.15	.28	.34	.19	.11	.26	.23	.15
B	.17	.07	.00	.22	.09	—.07	.25	.11	—.10	.20	.14	—.09	.11	.11	—.04	.06	.04	.12	.25	.02	—.02	.17	.08	—.02
C	.18	.00	.05	.17	.04	.03	.21	.04	—.01	.23	—.00	.00	.17	.07	—.04	.12	.03	.01	.25	.06	—.12	.17	.03	.01
D	.33	.22	.15	.39	.25	.07	.35	.23	.12	.32	.25	.13	.29	.26	.12	.22	.18	.27	.35	.18	.16	.31	.21	.16
Teats	.30	.12	—.03	.19	.13	.06	.23	.12	.02	.18	.19	—.00	.17	.12	.08	.09	.08	.18	.28	.13	—.03	.20	.13	.05
Milk veins	.33	.18	.19	.37	.17	.17	.27	.26	.18	.39	.07	.24	.26	.18	.29	.19	.23	.27	.30	.26	.15	.30	.19	.21
Size	—.00	.08	—.02	—.01	.05	.02	.05	.02	.01	.10	—.01	—.02	.01	.07	—.03	.03	—.01	.03	.05	.04	—.03	.03	.03	.00
G. app.	.23	.12	.08	.20	.13	.09	.31	.15	.02	.35	.15	—.06	.13	.23	.05	.20	.04	.16	.30	.13	.00	.20	.13	.07
Total score	.34	.22	.18	.36	.23	.16	.47	.22	.08	.43	.28	.06	.28	.31	.15	.33	.17	.24	.43	.22	.11	.38	.23	.15

*This average includes the results for milk veins but not those for total score since total score is dependent on each point. The average does not include the observation on which the judges are determined as good, fair or poor, e. g. in the Udder A averages the results .41, .20 and .04 are not included as this was the observation on which the Udder A groups of good, fair and poor judges were determined.

Body B. The able judge of a cow's milk yield on the basis of body B places his cows more nearly in their relative order of milk yield by the appearance of the following points, named in order of their relative importance; udder—broad, level; total score; rear udder; general appearance; fore udder; eyes, muzzle, and jaw; tail (table 8). Points of conformation wherein the good judges find most to indicate the milk producing capacities of the cow (table 9) are head; eyes and muzzle; neck; thighs; tail; udder, large sized; udder, broad and level; fore udder; rear udder; teats; milk veins; general appearance; total score. Among the characters in the use of which the good judges do not particularly excel the poor judges and yet have considerable value for the selection of the good milking cows from the poor ones may be mentioned the udder—large sized and the milk veins.

General appearance. The capable judge as determined by his ability to choose the high milking cow from the low one by the general appearance places his cows more nearly in their relative order of milk yield than the poor judge by examination of the following points of conformation; total score; fore udder; eyes full, muzzle broad; body wedged-shaped; size of cow; udder, broad, level; medium sized head (table 8). The points of conformation in which the good judges find most to indicate the good cow (table 9) are neck; body, wedged-shaped; udder, large size; udder, broad and level; the fore udder; the rear udder; milk veins; and total score. The points of conformation which seem to be equally valuable to the good and poor judges in selecting the productive cow from the unproductive cow are the udder size and the milk veins.

Body F. The better judges for this group place their cows most nearly in their relative order of milk yield by the fore udder (table 8.) Table 9 shows that the points of conformation wherein the good judge finds most to indicate the productive capacities of the good cow are the neck; the body, wedge-shaped; the udder, large size; the fore udder; the rear udder; the teats; the milk veins; and the total score. Among the points of conformation which have some value in indicating milk yield and yet are points in the use of which the good judges do not excel the poor judges in selecting the good milking cow from the poor one may be mentioned the udder, large size; teats; milk veins; the general appearance; the total score.

Body D. The good judge, as determined by his ability to choose most accurately the high milking cow from the low milking cow by the aid of the appearance of the rump, is able to place his cows more nearly in their relative order of milk yield than the poor judge by the appearance of lung capacity. Table 8 shows further that in the use of certain other points, as for example the fore udder, the good judge excels the poor judge but by an amount so small as to be scarcely significant. The points of conformation in which the good judges find most to indicate the good cows (table 9) are neck; body wedge-shaped; udder size; rear udder; milk veins; general appearance; and total score. The points which seem of about equal value to the good judge and to the poor judge in choosing the high milking cow from the low milking cow are body—wedge-shaped; udder size; rear udder; milk veins; general appearance; and total score.

Udder C. The correlation coefficients given in table 8 show that the good judge of dairy cattle in contrast to the poor judge, as determined by his ability to choose the high milk cow from the low one by the appearance of the fore udder, is able to place his cows more nearly in their relative order of milk yield by the following points of conformation given in their order of merit; general appearance; total score; thighs; body wedge shaped; teats; tail; udder, broad and level. Table 9 shows that the points in which the good judge finds most to indicate the productive capacities of the cow are neck; body wedge shaped; thighs; udder size; udder broad and level; fore udder; teats; milk veins; general appearance; and total score. Among those points, valuable in indicating probable high milk yield, in the use of which the good judges do not particularly excel the poor judges are the rear udder, and the milk veins.

THE POINTS OF CONFORMATION AND THE CATTLE JUDGES' PERSONAL EQUATION CONSIDERED FROM THE VIEWPOINT OF THE PREDICTION OF MILK YIELD.

The mass of evidence, just presented, may now be gathered together. The average Jersey cow making the Registry of Merit was found to be about 10 points under the ideal type. The most seriously defective of the parts making up the conformation were

the size and shape of the fore udder, size and shape of the whole udder and the size and character of the milk veins.

The average scores given the different points vary. The general appearance of the cow, the size and character of the udder, the size and shape of the fore udder, the size and shape of the rump, and the size and shape of the barrel are points of conformation for which the different judges give quite different scores. It is further shown for the points of conformation,—shape of udder and the body wedge shaped,—that as the average score given these parts by the different judges increases the milk yield also increases. In other words there is an approach to a standard for these parts of conformation which is recognized between judges. When the milk veins are studied it is found that they do not increase in score when the milk yield of the group of cows increases. Such a condition of affairs points to the probability that there is not the same recognized standard for the milk veins that there is for the udder and body shape.

The most valuable part of the conformation of the cow as indicated by the score is the shape of the udder. The general appearance of the cow and the shape of the fore udder have the most variation when scored by the different judges. Between each group of cattle, which fell to the lot of the judge to score, there is some correlation between the variation of the shape and size of the barrel and the variation in milk yield. A similar correlation exists for the variation of the fore udder and milk yield. Expressed in absolute terms this correlation means that the more variable the size and shape of the barrels or fore udders within a group the more variable are the milk yields of the cows within this group. the less variable the size and shape of barrels and fore udders the less variable the milk yields within this group.

The relative merit of the different parts of conformation, important in that they distinguish the high milk producing cow from the low producing cow, are total score, milk veins, rear udder, udder size, body wedge shaped, neck, teats, rump, thighs. These are the points of conformation which appear valuable for indicating the cows' milk yield in the hands of the average trained dairyman. To the individual judge, however, these points do not necessarily have the same values for determining milk yield that they have for the average trained dairyman. Thus in the nineteen judges studied, nine could judge dairy cattle by the score card and

select the better milkers, eight were fair judges, and two gave the lower producing cow the higher scores.

In the pages just presented we have analyzed our nineteen judges for their ability to judge dairy cattle for milk yield by means of the different parts of conformation, the ability of these judges being determined for each of the points of conformation which appeared to be valuable in revealing milk yield.

These points were total score, milk veins, size and texture of udder, size of rear udder, size and shape of body, general appearance of the cow, the space between the thighs, the length and breadth of rump, and the size and shape of the fore udder. These men's ability varied considerably for the different points.

Certain general conclusions of interest to dairy cattle breeders come from a study of this variation in the ability of the different judges. Three groups of judges good, fair, and poor were made for each item of conformation studied. There were eight different points of conformation by which the groups were made. A single judge may consequently appear in the good group eight times, or he may appear in the poor group eight times, or if his being in any one group is largely a matter of chance, he would be most likely to appear in some such proportion as twice in the good group, 3 times in the fair group and 3 times in the poor group. Were such a chance distribution true it would show that judging ability for one point of conformation does not predispose that judge to any greater ability for judging milk yield on any other point of conformation. However, if we find that the good judge, say for udder—large size not fleshy, is also a good judge for the other points it shows that judging ability on one point indicates such ability on other points of conformation. In other words judging ability is a generalized ability extending to all the points of conformation of the cow which are at all indicative of milk yield. The evidence, just presented, shows that the good judge for one point of conformation is likely to be the good judge for other points of conformation. Thus, judge 84 was classed as a good judge for all eight groups, judge 33 was classed as a good judge seven times and a fair judge once, judges 47 and 80 were fair judges twice and poor judges six times each. If the contingency coefficient be determined for the relation of position in one group to the relation of position in the other group it comes out to be .38 the slope being from good to poor. Thus the good

judges for one group tend to be good judges for all other groups and the poor judges of one group tend to be the poor judges of all other groups or broadly speaking judging ability is a generalized ability extending to each and every part of conformation which has value for milk yield.

In the pages just presented it has been shown that the good judges are good judges because they are able to place their cattle with regard to milk yield on certain points of conformation better than the poor judges. If these data be summarized we find that the good judge in contrast to the poor judge is able to place his cows more nearly in their relative order of milk yield by the total score; fore udder; udder—broad and level; rear udder; tail; body—wedge shape, with deep, large paunch. These are the points of conformation where the good judge displays his greatest skill. He is skillful in other points but not to the same degree.

The points of conformation wherein the good judges find most to indicate milk yield are total score; rear udder; body—wedge shaped, with deep, large paunch; milk veins; udder—large size; neck; teats; general appearance; thighs; udder—broad and level; fore udder. These are the points which are most valuable to the good judge for indicating milk yield, they need not necessarily be the points wherein the good judge's skill comes most into play. The poor judge may be as able or nearly as able as the good judge when using points like milk veins for the selection of the high producing cow from the poor one. Some points which have value for indicating the good cow to practically all judges are milk veins, rear udder, total score, and the udder—large size and not fleshy.

This study emphasizes, perhaps re-emphasizes another fact. Even when we choose the best judges the average correlation of the most valuable point for indicating milk yield (total score) is only .38; for the next point, rear udder, is only .31; for body—wedge shaped with large deep paunch is only .31 and for milk veins is only .30. Such results show that while the points of conformation are worth something as a means of predicting milk yield, still they are not worth as much as could be wished. If a comparison is made between these figures for the different points of conformation and that for a milk record of 7 days with the milk records of the 365-day lactation, of which it is a part, it is found that the milk record even so short as seven days is about

two times as valuable as an indicator of milk production over the full lactation period as is the conformation of the cow even though this conformation be judged by men of experience and proven ability. For the long time test of 365-days the comparison is still more in favor of the milk record.

We have shown that a personal equation exists for each judge and that this personal equation influences markedly the ability of the man to pick the high milking cows for the herd. No such personal equation need to exist for the milk scales for anyone can weigh milk accurately if he will. A milk record should therefore be carefully considered in choosing or in retaining the dairy cow in the herd.

Of course it is necessary occassionally to use conformation in selecting cows for the herd where no records are available. Under these conditions the buyer who is not sure of his ability will do well to stick pretty close to the points, milk veins, rear udder, total score, and udder—large size not fleshy, in selecting his cattle.